CHAPTER 4. SCREENING ANALYSIS

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4.1 INTRODUCTION

This chapter addresses the screening analysis that the U.S. Department of Energy (DOE) conducted in support of the ongoing energy conservation standards rulemakings for walk-in coolers and freezers (WICFs). In the market and technology assessment (chapter 3), DOE presented an initial list of technologies that can reduce the energy consumption of WICFs. The goal of the screening analysis is to screen out technologies that will not be considered further in the rulemaking analyses. Some of the technologies considered in chapter 3 can reduce annual energy consumption under real-world conditions, but may not increase the efficiency as measured under the DOE test procedure. DOE removed from consideration those technologies that do not decrease measured energy consumption. DOE evaluated the remaining technologies using the screening criteria set forth in the Energy Policy and Conservation Act (EPCA). (42 U.S.C. 6311–6317)

Section 325(o) EPCA establishes criteria for prescribing new or amended standards that are designed to achieve the maximum improvement in energy efficiency. Further, EPCA directs the Secretary of Energy to determine whether a standard is technologically feasible and economically justified. (42 U.S.C. 6295(o)(2)(A), as directed by 42 U.S.C. 6316(a)(1)–(3)). EPCA also establishes guidelines for determining whether a standard is economically justified. (42 U.S.C. 6295(o)(2)(B)) In view of the EPCA requirements for determining whether a standard is technologically feasible and economically justified, appendix A to subpart C of Title 10, Code of Federal Regulations, Part 430 (10 CFR Part 430), "Procedures, Interpretations, and Policies for Consideration of New or Revised Energy Conservation Standards for Consumer Products" (the Process Rule), sets forth procedures to guide DOE in its consideration and promulgation of new or revised efficiency standards. These procedures elaborate on the statutory criteria provided in 42 U.S.C. 6295(o) and, in part, eliminate problematic technologies early in the process of prescribing or amending an energy efficiency standard. In particular, sections 4(b)(4) and 5(b) of the Process Rule provide guidance to DOE for making a determination whether to eliminate from consideration any technology that presents unacceptable problems with respect to the following criteria:

Technological feasibility. Technologies incorporated in commercial equipment or in working prototypes will be considered technologically feasible.

Practicability to manufacture, install, and service. If mass production of a technology in commercial equipment and reliable installation and servicing of the technology could be achieved on the scale necessary to serve the relevant market at the time of the effective date of the standard, then that technology will be considered practicable to manufacture, install, and service.

Adverse impacts on equipment utility or equipment availability. If DOE determines that a technology has significant adverse impact on the utility of the equipment to significant subgroups of consumers, or result in the unavailability of any covered equipment type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as equipment generally available in the United States at the time, it will not be considered further.

Adverse impacts on health or safety. If DOE determines that a technology will have significant adverse impacts on health or safety, it will not be considered further.

In sum, if DOE determines that a particular technology or combination of technologies fails to meet one or more of the four criteria, it will be screened out. Section 4.3 below documents the reasons for eliminating any technology.

4.2 TECHNOLOGIES THAT DO NOT AFFECT CALCULATED DAILY ENERGY CONSUMPTION

As stated above, technologies that do not decrease measured energy consumption are not considered beneficial in the context of this rulemaking. Therefore, DOE removed the following technologies from consideration.

4.2.1 Non-Penetrative Internal Racks and Shelving

Many manufacturers have noted that often end users will install interior shelving units and racks in the walk-ins using penetrative fasteners such as nails and screws. These, by nature, compromise the inner metal skin and insulation of the envelope resulting in reduced insulating capacity and possibly air leakage. However, since manufacturers have little control over behavior of end-users and most shelving systems are now designed to be free-standing, this issue may be less important. In addition, the test procedure used to measure the daily energy performance of a WICF doesn’t account for any energy savings related to this equipment. Consequently, DOE did not consider non-penetrative racks and shelving in the engineering analysis.

4.2.2 Refrigeration System Override

A refrigeration system override would consist of an option to manually shut off the mechanical refrigeration system for select periods of time, such as during the loading and unloading of product. At these times, high traffic results in many door openings, or the door being left open altogether. In a conventional system, the refrigeration system continues to operate in an attempt to bring the temperature down to the desired value. An override would prevent this, meaning that less energy would be used during these periods. However, the DOE test procedure for WICF has no provision for the testing of walk-ins equipped with such systems, and thus there would be no reduction in energy consumption as tested. Consequently, DOE did not consider refrigeration system override in the engineering analysis.

4.2.3 Air and Water Infiltration Sensors

Infiltration of water and/or water vapor into the envelope insulating material may lead to significant reductions in the insulating capacity of the affected regions due to the thermal conductivity properties of water. This sort of infiltration may result from specific incidents, such as punctures or damage or a steady-state process occurring over a long period of time. A water condensate or vapor sensor, implanted within the insulating material would allow for early detection of damage to the insulating material. However, while the data may be useful for end-users and manufacturer, the technology doesn't directly result in a reduction in energy consumption. Consequently, DOE did not consider air and water sensors in the engineering analysis.

4.2.4 Humidity Sensors

Humidity of the air is another factor which can influence the performance of the mechanical refrigeration system. As more humid air has a higher enthalpy, it thus requires more energy to cool the air on a day with high humidity. Sensors installed in the system could provide real-time information regarding the outside humidity, which would allow for more informed decisions to be made regarding topics such as the loading and unloading of product at certain times. However, these sensors (except if they are used for the purposed of anti-sweat heater control) do not provide a means of directly reducing energy consumption. Consequently, DOE did not consider humidity sensors in the engineering analysis.

4.2.5 Heat Flux Sensors

For the same reasons as the humidity sensors mentioned above, DOE did not consider heat flux sensors in the engineering analysis.

4.2.6 Automatic Evaporator Fan Shut-Off

This control would automatically shut off evaporator fans whenever the walk-in door is opened. The result would be that less chilled air would be blown out into the surroundings, meaning that less energy would be needed to bring the interior space back down to temperature following a door opening. However, the proposed DOE test procedure contains no provision for calculating energy savings that would occur with such a system because the envelope (including doors) and the refrigeration system are tested separately. Consequently, DOE did not consider automatic evaporator fan shut-off in the engineering analysis.

4.2.7 Hot Gas Defrost

Hot gas defrost utilizes heat generated from the system in order to defrost the evaporator coil rather than using a dedicated electric defrost coil. However, operation of a hot gas defroster requires that the compressor and fans continue to run, meaning that the entire mechanical refrigeration system is still operating. Generally, these components collectively require an energy input that is greater than that needed to operate an electrical defroster. This means that hot gas defrost would not greatly affect energy consumption as measured under the test procedure. Additionally, the test procedure contains no provision for testing a system connected to a remote rack which utilizes hot gas defrost. Consequently, DOE did not consider hot gas defrost in the engineering analysis.

4.3 SCREENED-OUT TECHNOLOGIES

This section addresses the technologies that DOE screened out because they did not meet the requirements of sections 4(a) and 5(b) of the Process Rule. DOE considered the following four factors: (1) technological feasibility; (2) practicability to manufacture, install, and service; (3) adverse impacts on equipment utility to consumers; and (4) adverse impacts on health or safety. The technologies that were screened out are: higher efficiency evaporator fan motors, external heat rejection, and energy storage systems.

4.3.1 Revolving Doors

A provision for the reduction of losses from door opening would be the use of revolving doors. Like vestibule entries, revolving door systems are commonly used for the entryways of large buildings. Similarly, they prevent direct exchange of air and reduce the rate of infiltration compared to a standard door. By reducing direct air exchange the associated energy savings are quite significant.

However, in order to prevent the utility of a walk-in from being impacted, the size of the door must accommodate a person plus space for carrying or moving products into the walk-in. Doors of this size do exist but are prohibitively expensive for medium to small sized units. In addition, these type of doors require a large foot print, reducing useable floor area for storage or other use. For these reasons, DOE did consider revolving doors in the engineering analysis.

4.3.2 Fiber Optic Natural Lighting

Fiber optic lighting systems are in use in the building industry. However, in this analysis, DOE has not encountered any such systems either in prototype or manufactured and sold for walk-in operations. As a result, DOE screened out fiber optic natural lighting on the grounds of technological infeasibility.

4.3.3 Energy Storage Systems

One proposed technology included the incorporation of thermal storage media which could be cooled during the overnight hours and then used to lessen the refrigeration load during the peak daytime operating period. However, in this analysis, DOE has not encountered any such systems either in prototype or manufactured and sold for walk-in operations. As a result, DOE screened out energy storage systems on the grounds of technological infeasibility.

4.3.4 Non-Electric Anti-sweat Systems

While it is technically possible to perform door heating with non-electric primary energy resources, DOE has not encountered any such systems either in prototype or manufactured and sold for walk-in operations. As a result, DOE screened out fiber optic natural lighting on the grounds of technological infeasibility.

4.3.5 Automatic Insulation Deployment Systems

A system that enhanced the insulation of glass display doors during non-business hours would significantly reduce energy consumption without impacting utility of the walk-in. However, in this analysis, DOE has not encountered any such systems either in prototype or manufactured and sold for walk-in operations. As a result, DOE screened out automatic insulation deployment systems on the grounds of technological infeasibility.

4.3.6 Higher Efficiency Evaporator Fan Motors

The provisions of EISA mandate that WICF evaporator fans be equipped with electronically commutated motors (ECMs). In this analysis, DOE has not encountered any electric motor technologies which perform more efficiently than the ECMs already required for this application. As a result, DOE has screened out the possibility of using higher efficiency evaporator fan motors on the grounds of technological infeasibility.

4.3.7 3-Phase Motors

3-phase motors can save energy over single-phase motors; however, use of 3-phase motors requires 3-phase power. Not all businesses that use walk-ins are equipped with 3-phase power, and therefore must use single-phase equipment. DOE screened out this design option on the grounds of utility.

4.3.8 Economizer Cooling

Economizer cooling consists of directly venting outside air into the interior of the walk-in when the outside air is as cold as or colder than the interior of the walk-in. This relieves load on the refrigeration system when pull-down load is necessary. However, this presents a utility issue, as ambient temperatures in some areas of the country rarely or never reach temperatures as low as those inside a walk-in. Because the utility of this technology is constrained by the walk-in’s location or region, DOE screened out economizer cooling as a design option for improving the energy efficiency of walk-in coolers and freezers.

4.4 REMAINING TECHNOLOGIES

After eliminating those technologies that do not decrease energy consumption as measured by the test procedure, and do not meet the requirements of sections 4(a) and 5(b) of the Process Rule, DOE is considering the following technologies:

- Improved wall, ceiling, and floor insulation
- Improved door gaskets and panel interface systems
- Electronic lighting ballasts and high-efficiency lighting
- Occupancy sensors
- Automatic door opening and closing systems
- Air curtains

- Strip curtains
- Vestibule entryways
- Display and window glass system insulation performance
- Anti-sweat heater controls
- No anti-sweat systems
- Ambient subcooling
- Higher-efficiency compressors
- Evaporator fan control
- Evaporator and condenser fan blades
- Higher-efficiency condenser fan motors
- Improved evaporator and condenser coils
- Defrost controls
- Floating head pressure